Original Article

Influence of primary payer status on non-ST-segment elevation myocardial infarction: 18-year retrospective cohort national temporal trends, management and outcomes

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Background: The role of insurance on outcomes in non-ST-segment-elevation myocardial infarction (NSTEMI) patients is limited in the contemporary era.

Methods: From the National Inpatient Sample, adult NSTEMI admissions were identified [2000–2017]. Expected primary payer was classified into Medicare, Medicaid, private, uninsured and others. Outcomes included in-hospital mortality, overall and early coronary angiography, percutaneous coronary intervention (PCI), resource utilization and discharge disposition.

Results: Of the 7,290,565 NSTEMI admissions, Medicare, Medicaid, private, uninsured and other insurances were noted in 62.9%, 6.1%, 24.1%, 4.6% and 2.3%, respectively. Compared to others, those with Medicare insurance older (76 *vs.* 53–60 years), more likely to be female (48% *vs.* 25–44%), of white race, and with higher comorbidity (all P<0.001). Population from the Medicare cohort had higher in-hospital mortality (5.6%) compared to the others (1.9–3.4%), P<0.001. With Medicare as referent, in-hospital mortality was higher in other {adjusted odds ratio (aOR) 1.15 [95% confidence interval (CI), 1.11–1.19]; P<0.001}, and lower in Medicaid [aOR 0.95 (95% CI, 0.92–0.97); P<0.001], private [aOR 0.77 (95% CI, 0.75–0.78); P<0.001] and uninsured cohorts [aOR 0.97 (95% CI, 0.94–1.00); P=0.06] in a multivariable analysis. Coronary angiography (overall 52% *vs.* 65–74%; early 15% *vs.* 22–27%) and PCI (27% *vs.* 35–44%) were used lesser in the Medicare population. The Medicare population had longer lengths of stay, lowest hospitalization costs and fewer home discharges.

Conclusions: Compared to other types of primary payers, NSTEMI admissions with Medicare insurance had lower use of coronary angiography and PCI, and higher in-hospital mortality.

Keywords: Myocardial infarction; insurance; health disparities; primary payer; outcomes research

Introduction

In the United States every year 450,000 patients are admitted for non-ST-segment elevation myocardial infarction (NSTEMI), accounting for nearly 70% of the total patients with acute coronary syndrome (1). While the average age of patients with ST-segment-elevation myocardial infarction has decreased (66±14 to 63±14 years) from 1995 to 2015, the average age of patients with NSTEMI has remained stable during this time (68±14 years) (2). Patients presenting with NSTEMI have been shown to have a higher risk of long-term mortality attributed to their higher rate of comorbidities and multi-vessel disease as compared to patients with other forms of acute coronary syndrome (3,4). Prior data have shown insurance status of the patient to impact the overall outcomes of patients presenting with acute myocardial infarction (5,6). Multiple retrospective trials show that the lack of health insurance and Medicaid status is associated with worse outcomes compared with privately insured patients (5-8). Though prior studies have assessed payer-mix outcome association among patients with ST-segment-elevation myocardial infarction (STEMI), there are limited data analyzing patients across primary payer categories (government, private and other insurances, as well as uninsured patients) and their outcomes in patients hospitalized with NSTEMI (5,6,8). Using an 18-year national database, we sought to assess the management and outcomes of NSTEMI by primary payer status. This study also evaluated the temporal trends in admissions, use of cardiac and non-cardiac procedures, and clinical outcomes of these populations. This manuscript has been prepared using the guidelines of the STROBE (STrengthening the Reporting of Observational studies in Epidemiology) reporting checklist (available at http://dx.doi.org/10.21037/atm-20-5193).

Methods

Study population, variables and outcomes

The Health care Quality and Utilization Project-National (Nationwide) Inpatient Sample (HCUP-NIS contains discharge data from a 20% stratified sample of community hospitals (9). Information regarding each discharge includes patient and hospital demographics (9). The study was conducted in accordance with the Revised Declaration of Helsinki (as revised in 2013). Institutional Review Board approval was not sought due to the publicly available nature

of the de-identified data. These data are publicly available for those interested with the Agency for Healthcare Research and Quality.

During 2000–2017, NSTEMI (in the primary diagnosis field) admissions (≥18 years) with NSTEMI [International Classification of Diseases 9.0 Clinical Modification (ICD-9CM) 410.70-410.79 and ICD-10CM I21.4, I.22.2] were identified (10-14). The HCUP-NIS classified expected insurance primary payers as Medicare, Medicaid, private insurance, uninsured (self-pay or no charge) and others (5,6). The Deyo's modification of the Charlson Comorbidity Index was used to identify the burden of co-morbid diseases (Table S1) (15). Clinical and demographic variables were identified for all admissions (10,16-38). Early coronary angiography was defined as those occurring on hospital day zero (19,29). The hospital day of the performance of the procedure was used to time concomitant procedures (16,24,26,29,30).

In-hospital mortality in NSTEMI admissions by insurance was the primary outcome. Secondary outcomes included temporal trends in admissions, use of coronary angiography, early coronary angiography, percutaneous coronary intervention (PCI), mechanical circulatory support (MCS), coronary artery bypass grafting (CABG), hospitalization costs, length of hospital stay and discharge disposition.

Statistical analysis

In this study, discharge weights from the HCUP-NIS provided with HCUP-NIS database were used to generate national estimates, including re-weighting of the 2000–2011 sample to adjust for the 2012 re-design (39). Multivariable logistic regression was used to analyze trends over time (referent year 2000). One-way analysis of variance and *t*-tests were used to compare categorical and continuous variables, respectively. Multivariable logistic regression analysis incorporating age, sex, race, socio-economic stratum, hospital characteristics, comorbidities, year of admission, cardiogenic shock, cardiac arrest, do-not-resuscitate (DNR) status and palliative care referral was performed for assessing coronary angiography and temporal trends of coronary angiography. Multivariable logistic regression analysis incorporating age, sex, race, socio-economic stratum, hospital characteristics, comorbidities, year of admission, cardiogenic shock, cardiac arrest, acute respiratory failure, acute kidney injury, systolic heart failure, prior CABG, complications, cardiac procedures,

non-cardiac procedures, DNR status and palliative care referral was performed for assessing in-hospital mortality and temporal trends of in-hospital mortality. To confirm the results of the primary analysis, sensitivity analyses were performed stratifying the population by age (≤/>75 years), race (white/non-white), tertiles of study period, sex, use of PCI and use of DNR status/palliative care referral. The best practices with respect to the limitations of the HCUP-NIS database related to research design, data analysis and interpretation, were used in this study (39,40). SPSS v25.0 (IBM Corp., Armonk, NY, USA) was used for all analyses.

Results

In the period from January 1, 2000 to December 31, 2017, there were 7,302,447 NSTEMI admissions, of which primary payer status was missing in 11,881 (0.2%). In the final cohort of 7,290,565 NSTEMI admissions, Medicare, Medicaid, Private, Uninsured and Others constituted 4,582,626 (62.9%), 445,298 (6.1%), 1,755,970 (24.1%), 336,942 (4.6%) and 169,730 (2.3%), respectively. The Medicare population was older, more often female, of white race, and with higher comorbidity (all P<0.001) (*Table 1*). Individuals with Medicare and other insurance categories were more frequently admitted to rural hospitals and had higher rates of prior CABG (*Table 1*). Cardiogenic shock

and cardiac arrest were noted less frequently in the private insurance cohort (*Table 1*). The Medicare cohort had higher rates of acute respiratory failure, acute kidney injury and complications (vascular complications, hemorrhage, blood transfusion and ischemic stroke) (*Table 1*).

In the Medicare population, coronary angiography was used less frequently (51.5%) compared to the others (65.9–74.4%) during this 18-year period. There was a steady increase in the use of coronary angiography across all insurance sub-groups (*Figure 1*); however, the Medicare cohort had consistently lower use (*Figure 1A*). Compared to 2000, in adjusted analyses, all categories showed an increase in the use of coronary angiography over the years (*Figure 1B*). In a multivariable logistic regression analysis (Medicare referent), Medicaid had lower use of coronary angiography {odds ratio (OR) 0.88 [95% confidence interval (CI), 0.87–0.89]}, whereas all other insurance categories had higher use—private insurance [OR 1.38 (95% CI, 1.38–1.39]], uninsured [OR 1.18 (95% CI, 1.17–1.19)] and other insurance [OR 1.19 (95% CI, 1.17–1.20)]; all P<0.001 (Table S2). Early coronary angiography, PCI, CABG and MCS were used less frequently in the Medicare population as compared to the other cohorts (*Table 2*). During this 18-year period, there was a steady increase in early coronary angiography and PCI use across all 5 cohorts; however, the Medicare group had consistently lower utilization

Table 1 Characteristics of non-ST-segment elevation myocardial infarction admissions stratified by primary payer status

Characteristics	Medicare (N=4,582,626)	Medicaid (N=445,298)	Private (N=1,755,970)	Uninsured (N=336,942)	Others (N=169,730)	P
Age (years)	76.0±10.3	55.8±11.3	58.3±11.1	53.6±10.4	60.5±12.5	<0.001
Female sex	48.1	44.4	30.6	32.0	25.6	<0.001
Weekend admission	25.3	25.2	25.1	25.6	24.2	<0.001
Race						
White	67.5	44.0	63.4	52.5	58.1	<0.001
Black	8.0	18.2	8.1	15.0	10.7	
Others[a]	24.6	37.8	28.5	32.5	31.2	
Quartile of median household income for zip code						
0–25th	25.8	40.0	19.5	35.6	30.5	<0.001
26th–50th	27.6	27.5	25.1	28.7	29.1	
51st–75th	24.0	19.7	26.2	21.7	23.2	
75th–100th	22.6	12.7	29.1	14.0	17.1	

Table 1 (*continued*)

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Table 1 (*continued*)

Characteristics	Medicare (N=4,582,626)	Medicaid (N=445,298)	Private (N=1,755,970)	Uninsured (N=336,942)	Others (N=169,730)	P
Charlson Comorbidity Index						
0–3	25.8	66.9	71.3	79.0	65.6	<0.001
4–6	49.0	27.1	23.4	18.2	26.3	
≥7	25.2	6.1	5.3	2.7	8.1	
Hospital teaching status and location						
Rural	12.0	8.5	7.5	9.0	11.7	<0.001
Urban non-teaching	40.0	32.1	39.4	37.5	36.2	
Urban teaching	48.0	59.4	53.1	53.5	52.0	
Hospital bed-size						
Small	12.0	10.5	10.7	10.1	9.5	<0.001
Medium	26.1	25.5	25.7	25.4	25.2	
Large	61.9	64.0	63.6	64.5	65.4	
Hospital region						
Northeast	21.6	22.7	20.0	12.9	10.5	<0.001
Midwest	22.9	20.4	23.1	17.6	18.5	
South	39.7	34.6	39.0	58.8	48.7	
West	15.8	22.3	17.9	10.7	22.3	
Prior coronary artery bypass grafting	11.9	6.9	6.4	4.4	8.0	<0.001
Cardiogenic shock	2.9	2.6	1.9	2.2	2.8	<0.001
Cardiac arrest	2.9	2.9	2.3	2.4	2.7	<0.001
Acute respiratory failure	9.5	8.0	4.9	5.2	7.1	<0.001
Acute kidney injury	16.0	13.3	7.4	8.2	11.1	<0.001
Systolic heart failure	9.8	9.4	4.7	6.3	7.4	<0.001
Vascular complications	0.8	0.7	0.7	0.6	0.7	<0.001
Hemorrhage	2.7	2.6	2.0	1.8	2.2	<0.001
Blood transfusion	8.8	6.9	4.9	4.6	5.3	<0.001
Ischemic stroke	2.0	1.4	1.0	1.1	1.2	<0.001
Intracranial hemorrhage	0.2	0.2	0.1	0.1	0.1	<0.001
Intravascular ultrasound	1.2	1.8	2.0	1.8	1.9	<0.001
Coronary thrombectomy	0.3	0.5	0.4	0.3	0.5	<0.001
Pulmonary artery catheterization	0.9	1.0	0.9	0.9	1.0	<0.001
Invasive mechanical ventilation	5.0	5.3	3.2	3.7	4.2	<0.001
Hemodialysis	0.7	0.8	0.4	0.4	0.5	<0.001

Represented as percentage or mean ± standard deviation; [a]Hispanic, Asian, Native American, Others.
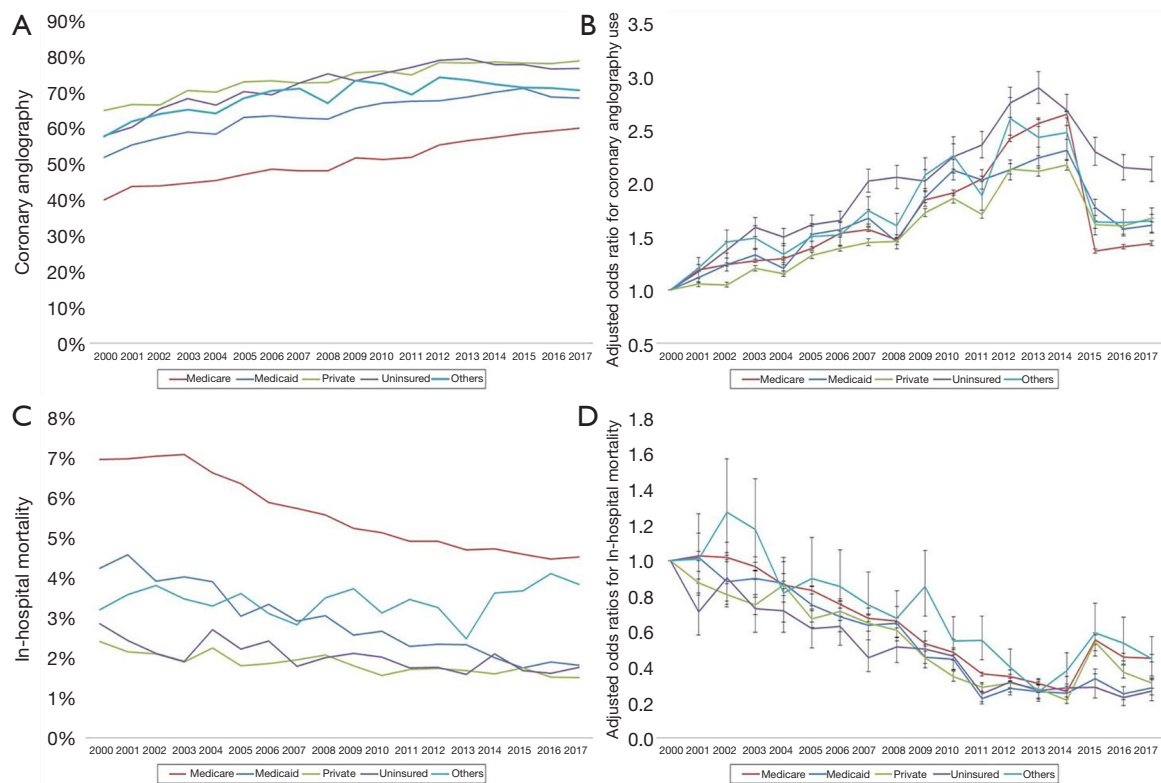
Figure 1 Eighteen-year trends in the use of coronary angiography and in-hospital mortality in NSTEMI admissions stratified by primary payer status. (A) Unadjusted trends of coronary angiography; P<0.001; (B) adjusted trends of coronary angiography (referent: 2000)*; P<0.001; (C) unadjusted trends of in-hospital mortality; P<0.001; (D) adjusted temporal trends of in-hospital mortality (referent: 2000)**; P<0.001. *Adjusted for age, race, sex, hospital characteristics, socio-economic stratum, comorbidities, do-not-resuscitate status, palliative care referral, cardiogenic shock, cardiac arrest; **Adjusted for age, race, sex, hospital characteristics, socio-economic stratum, comorbidities, do-not-resuscitate status, palliative care referral, cardiogenic shock, cardiac arrest, acute kidney injury, systolic heart failure, prior CABG, acute respiratory failure, complications, non-cardiac and cardiac procedures. NSTEMI, ST-segment elevation myocardial infarction.

(*Figure 2A,B*). There was a steady increase in CABG use until 2005, after which it remained relatively stable (*Figure 2C*). MCS use was relatively stable during this study period, with the Medicare population consistently having lower use of MCS (*Figure 2D*). Palliative care and DNR status use were low (≤4%) and was higher in individuals with Medicare and Other insurance categories (*Table 2*).

Medicare had higher unadjusted all-cause in-hospital mortality (5.6%) compared to the other groups (1.9–3.4%) (*Table 2*). The Medicare population had consistently higher in-hospital mortality during the 18-year study period, despite a comparable decline in 2017 compared to 2000 across all cohorts (*Figure 1C,D*). In a multivariable logistic regression analysis with Medicare as the referent population, in-hospital mortality was higher in the other insurance [OR 1.15 (95% CI, 1.11–1.19); P<0.001], and lower in all other

populations—Medicaid [OR 0.95 (95% CI, 0.92–0.97); P<0.001], privately insured [OR 0.77 (95% CI, 0.75–0.78); P<0.001] and uninsured cohorts [OR 0.97 (95% CI, 0.0.94–1.00); P=0.06] (Table S3). Multiple sensitivity analyses were performed to confirm the results of the primary findings. The Medicare population had consistently higher in-hospital mortality compared to the other cohorts except in admissions aged >75 years and those with palliative care/ DNR status use (Table S4). The Medicare and Medicaid populations had longer lengths of hospital stay (*Table 2*).

Discussion

In this large contemporary study looking at the impact of insurance status on NSTEMI, Medicare beneficiaries differed significantly in age and socio-demographic

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Table 2 Clinical outcomes of non-ST-segment elevation myocardial infarction admissions stratified by primary payer status

| Outcomes	Medicare (N=4,582,626)	Medicaid (N=445,298)	Private (N=1,755,970)	Uninsured (N=336,942)	Others (N=169,730)	P
Coronary angiography	51.5	65.9	74.4	74.1	70.1	<0.001
Early coronary angiography (day zero)	14.6	21.6	26.5	25.8	23.1	<0.001
Percutaneous coronary intervention	26.5	34.9	44.3	43.2	39.9	<0.001
Coronary artery bypass grafting	8.5	10.9	12.5	11.9	12.0	<0.001
Mechanical circulatory support	2.6	3.1	3.0	3.0	3.3	<0.001
Palliative care referral	1.6	0.6	0.5	0.4	1.6	<0.001
Do-not-resuscitate status	4.2	1.0	0.7	0.5	2.0	<0.001
In-hospital mortality	5.6	2.7	1.9	2.0	3.4	<0.001
Length of stay (days)	5.7±5.9	5.4±7.1	4.2±4.8	4.3±5.2	4.6±5.0	<0.001
Hospitalization costs (×1,000 US Dollars)	57±76	70±94	59±72	61±68	63±79	<0.001
Disposition						
Home	50.9	68.5	73.1	78.2	70.9	<0.001
Transfer	12.0	11.9	14.5	12.7	13.9	
Skilled nursing facility	21.3	7.2	4.8	2.2	6.9	
Home with HHC	15.1	9.5	7.0	4.2	6.8	
Against medical advice	0.7	3.0	0.6	2.6	1.5	

Represented as percentage or mean ± standard deviation. ECMO, extracorporeal membrane oxygenation; HHC, home health care; IABP, intra-aortic balloon pump; pLVAD, percutaneous left ventricular assist device.

characteristics. The Medicare beneficiaries consistently received less frequent cardiac procedures such as coronary angiography (including early coronary angiography), PCI, CABG and MCS and had higher rates of in-hospital complications. Individuals with Medicare coverage had worse in-hospital outcomes and less frequent discharges to home. Though age may partly explain these differences, there remain significant differences between the various insurance categories.

When compared with ST-segment-elevation AMI, patients with NSTEMI are less likely to undergo PCI during their index hospitalization, are less likely to be discharged on evidence-based medications (4). Though prior studies have shown the impact of insurance on ST-segment-elevation MI patients, there are limited data in those with NSTEMI (5,6). Data from the early 2000s suggested that the primary payer status significantly influences the management of NSTEMI patients and subsequently their in-patient and overall outcomes (8,41). This is especially important as type of insurance and financial constraints in both insured and uninsured patients leads to prehospital

delays causing higher morbidity and mortality in patients with NSTEMI (42). Our study showed that NSTEMI patients with Medicare had a higher mortality and worse overall outcomes compared with the other insurance sub-groups, while consistently receiving less frequent interventions. Consistent with prior studies, we note a lower use of coronary angiography in Medicare populations as compared to patients supported by other primary payers (43,44). A retrospective study from the CRUSADE, which included 19,755 NSTEMI patients, demonstrated overall lower utilization of coronary revascularization procedures (either PCI or CABG) in older Medicare population with NSTEMI (43). Another study analyzing the ACTION Registry noted >50% of all older patients who did not undergo cardiac revascularization during their index hospitalization to received medical management only (44). These findings are similar to our study for which we used the HCUP-NIS data from 2000–2017 of NSTEMI patients and found that there was increase in the use of in coronary angiography across all insurance sub-groups, nonetheless there was consistently lower use of coronary angiography in
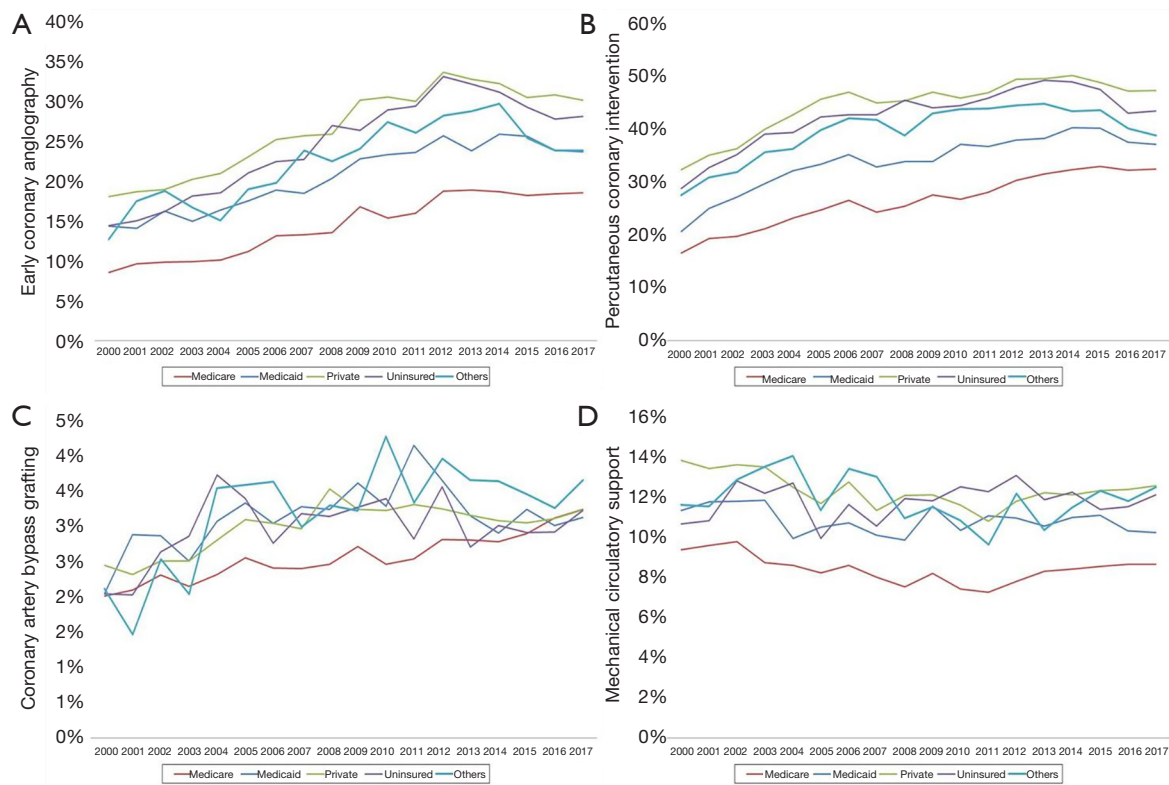
Figure 2 Eighteen-Year trends of early coronary angiography (A), percutaneous coronary intervention (B), coronary artery bypass grafting (C) and mechanical circulatory support (D). All P<0.001.

Medicare patients (51.5%) compared to the other cohorts (65.9–74.4%). There are several potential explanations for this finding. First, we found a higher burden of co-morbidities and significantly higher rate of prior CABG in our Medicare population, both of which are associated with lower utilization of coronary angiography (37). Second, compared to other groups our study reports that Medicare patients were more often admitted to rural hospitals than urban hospitals. Onsite availability of high technology procedure is associated with increased utilization, regardless of payer status (41). Though it is observed that patients in rural hospitals receive similar quality of care and overall outcomes, but are less likely to be equipped with on-site interventional cardiology and perform significantly lower number of revascularization procedures compared to urban centers (45). Finally, we observed that Medicare population had a higher inpatient rate of acute respiratory failure, acute kidney injury and complications (vascular, hemorrhagic, blood transfusion and ischemic stroke) which may have impacted to decisions to avoid invasive procedures. Along with lower low-risk invasive procedures like coronary

angiography, our study also demonstrated lower use of other cardiac procedures like CABG and MCS placement in Medicare patients presenting with NSTEMI. Higher surgical risk in the setting significantly elevated comorbidity burden along with the aforementioned reasons for lower catheterization use may explain this finding.

Previous studies have demonstrated that although Medicaid patients and uninsured patients with presenting with acute MI have better access to catheterization laboratories, they had significantly lower probability of undergoing cardiac procedures (8). Prior studies from the ST-segment elevation MI population have shown Medicaid beneficiaries have a lower rate of revascularization, and higher in-hospital mortality (5,6). Similarly, with no prior data on the NSTEMI subpopulation, in a multivariable logistic regression analysis with Medicare population as reference category, we found coronary angiography was used less often in the Medicaid population. Lower socioeconomic status and poor access to regular healthcare may contribute to this phenomenon. Further, Medicaid beneficiaries tend to present in non-PCI capable centers

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and have a higher rate of inter-facility transfer, which may contribute to lower use of cardiac catheterization (6).

An analysis of elderly patients with Medicare presenting with NSTEMI compared to private insurance from CRUSADE initiative, Calvin *et al.* reported frequency of unadjusted mortality was higher in Medicare patients but that association disappeared after adjusting for baseline characteristics (8). The same study also found that Medicaid patients <65 years old had a greater risk of adjusted in-hospital mortality compared to those with private insurance (OR 1.33; 95% CI, 1.08–1.63) (8). We observed in-hospital mortality was highest in those with Medicare insurance. Though age may play a significant part in this, our study finding of higher baseline comorbidities, lower use of cardiac procedures and higher rates of complications are important contributors. Prior data from the ACTION registry of NSTEMI patients who were not revascularized during their initial hospitalization, noted a higher risk of mortality and readmission for MI (44). Prior data from NSTEMI populations using the Medicare database, has shown superiority of an early invasive strategy in this population. Though not described in our study these patients also have poor long-term mortality. There appears to be poor drug adherence in Medicare patients to medications for secondary prophylaxis after an admission for AMI (46). Registry data have shown that medically managed NSTEMI patients who did not undergo early catheterization or early PCI were less likely to receive evidence-based medications compared with those who received early catheterization and PCI, respectively (47). All these factors combined appear to be contributing to poor in-patient and overall outcomes in older Medicare beneficiaries presenting with NSTEMI. This is supported by our finding of higher rates of DNR and palliative care use in lower discharges home in patients with Medicare in this study.

Limitations

This study has several limitations. Insurance status is frequently associated with other socio-economic categories, which cannot be fully evaluated using an administrative database. Patient, family and provider specific beliefs, which are known to influence outcomes relating to cardiac procedures, could not be measured in this database. The lack of angiographic data, such PCI location, lesion classification, presence of multi-vessel disease, and revascularization failure, that may significantly influence outcomes, were not available in this database. This study does not study post-hospital long-term complications after PCI and NSTEMI. Despite these limitations, this study addresses a significant knowledge gap highlighting the clinical outcomes of NSTEMI when evaluated using an insurance perspective.

Conclusions

Compared with other types of insurance, NSTEMI admissions with Medicare differ significantly from other categories as evidenced by lower use of cardiac procedures, have worse complications, and poorer in-hospital outcomes. Further data are needed to understand the complex socio-demographic dynamics associated with insurance coverage which may determine quality of care in this acutely ill population.

Acknowledgments

Footnote

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Revised Declaration of Helsinki (as revised in 2013). Institutional Review Board approval was not sought due to the publicly available nature of the de-identified data.

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